Optimize FPGA & SoC Configuration for Speed, Resilience & Adaptability

2Q 2024

Paul Chopelas, General Manager, Aerospace & Defense
Avalanche Technology

avalanche *technology*

Agenda

Roadmap Update

Qualification and Ecosystem Update
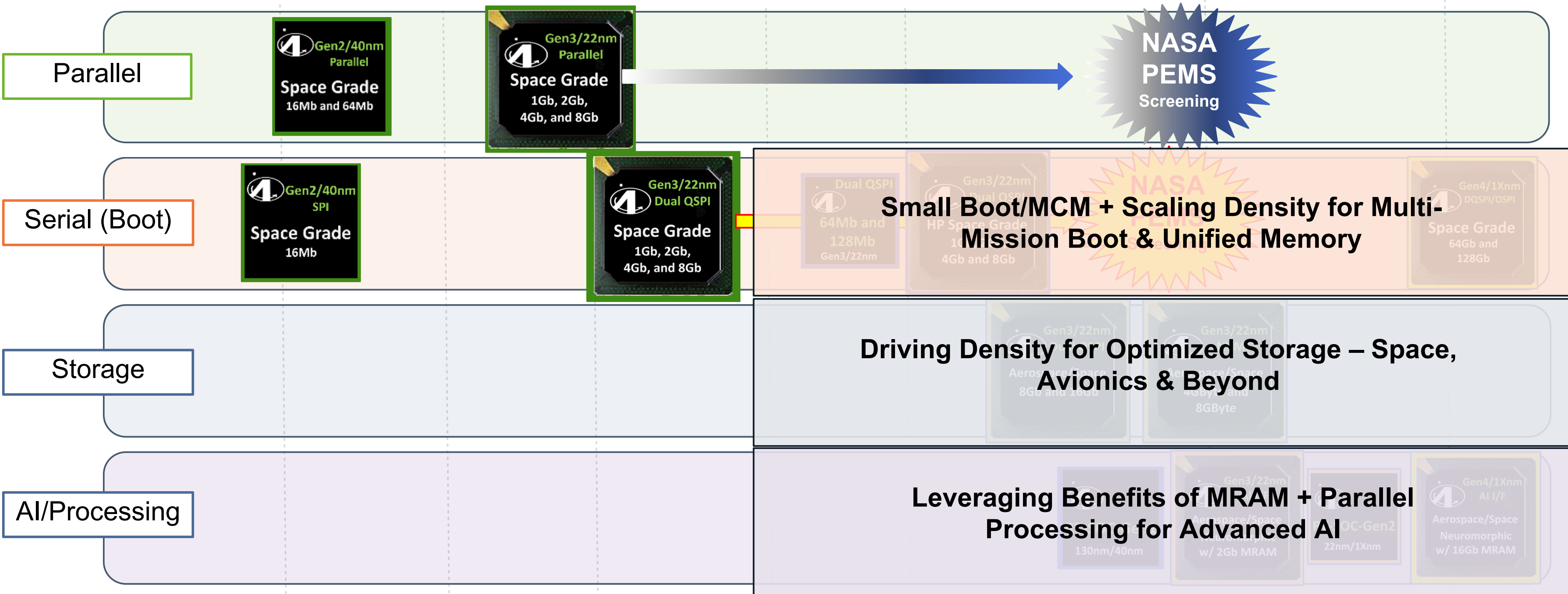
Boot Solutions – Device Level

Enabled Platforms – Storage

Enabled Platforms – Board & Device

Recap

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Roadmap Update

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Avalanche MRAM/Processing Product Roadmap

Avalanche MRAM Solutions Available Today

Parallel MRAM – Large 1Gb, 2Gb, 4Gb & 8Gb

Parallel

Serial (Boot)

Storage

AI/Processing

- **Shipping in volume**
- **Qual & Screening Options:**
  - Avalanche Space Grade JEDEC qual – complete, report available
  - NASA-INST-001 PEMS – FrontGrade, Micross
  - QML - Micross
- **Radiation Tested**
- **Largest MRAM Density Available**

Gen 2   Gen 3

2020   2021   2022   2023   2024   2025   2026+

Preproduction   Development
Production   Planned

Avalanche MRAM Solutions Available Today – Ideal for Configuration

Serial MRAM (Dual QSPI) -1Gb, 2Gb, 4Gb & 8Gb

- **Shipping in volume**
- **Qual & Screening Options:**
  - Avalanche Space Grade JEDEC qual in progress
  - NASA-INST-001 PEMS – FrontGrade, Micross and Avalanche
  - QML - Micross
- **Radiation Tested**
- **Largest MRAM Density Available**
  - Petalinux Drivers available for AMD/Xilinx FPGA

Parallel — **Serial (Boot)** — **Storage** — **AI/Processing**

2020 · 2021 · 2022 · 2023 · 2024 · 2025 · 2026+

Gen 2 · **Gen 3**

Legend: Preproduction (blue) · Development (orange) · Production (green) · Planned (yellow)

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Low Density Serial (Dual QSPI) – 64Mb and 128Mb Gen3

Standard FBGA96
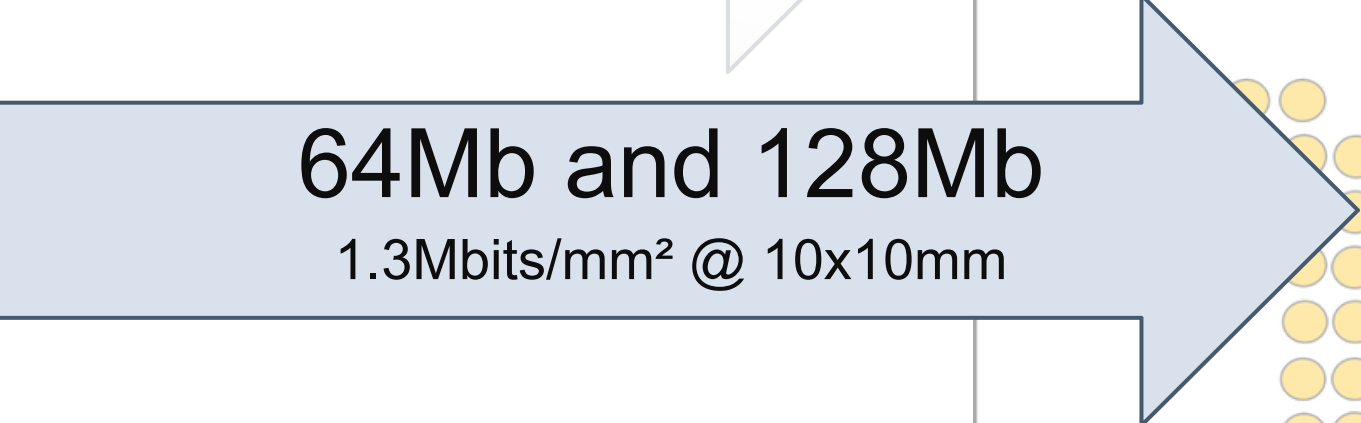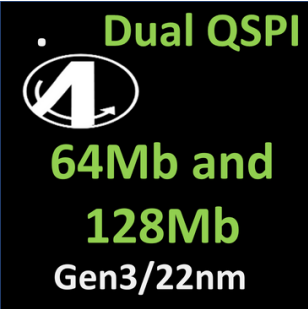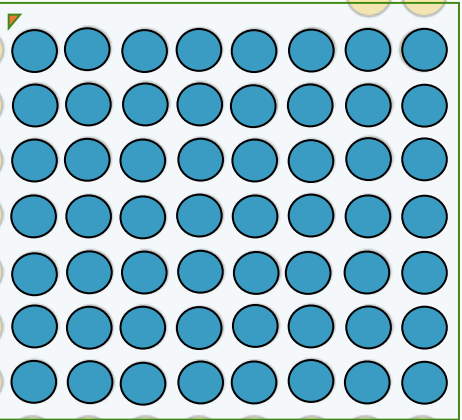
Gen3/22nm Dual QSPI

Space Grade
1Gb, 2Gb, 4Gb, and 8Gb

1Gb, 2Gb, 4Gb and 8Gb
21Mbits/mm² @ 20x20mm

20mm

Dual QSPI
64Mb and 128Mb
Gen3/22nm

64Mb and 128Mb
1.3Mbits/mm² @ 10x10mm

10mm

10mm

20mm

Open for Ordering

Leverages Gen3 Radiation Legacy

Ultra Low Power (~15mA per device)

Ideal for Advanced SoC/FPGA boot
Compact images
Flexible, but robust write protection schemes

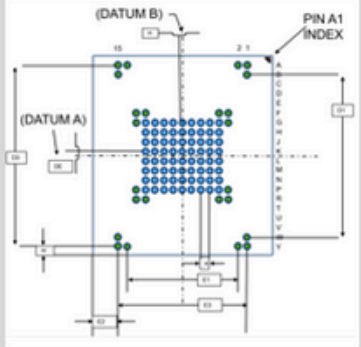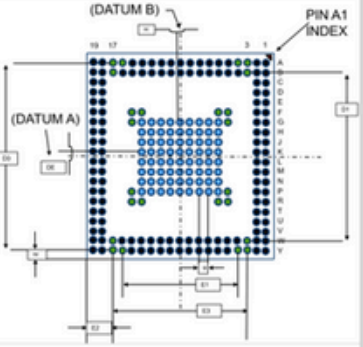**Single or Dual QSPI Interface**

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Space Grade vs Space Grade-E- *Preview*

	Space Grade DQSPI	Space Grade-E DQSPI
MRAM die	Gen 3 1Gb die, stacked to x1, 2, 4, or 8	
Endurance	10^{16} write cycles	
Retention	20 years at 85degC	
Interface chiplet	RT-FPGA	22nm RHBD
Package (footprint & electrically compatible)	96 ball FBGA (20x20mm)	224 ball FBGA (20x20mm)
Performance	54MHz SDR/ 40MHz DDR	100MHz SDR / 50 MHz DDR
TID	75krad	300krad
LET	45MeV**	~75MeV**
Availability	Production	mid-2024 sampling

HP-DQSPI specs are preliminary, subject to additional testing & validation.

**See datasheet for guidance

Status

Open for Ordering

Space Grade DQSPI:
In production since 6/23
JEDEC qual 2Q24

Space Grade-E DQSPI:
Prototyping 3Q24
JEDEC qual 2025

Advantages

Faster Booting

Improved Radiation Performance

Improved Mechanical Robustness

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Qualification and Ecosystem

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Powered by Avalanche – MRAM Device Ecosystem

Industrial
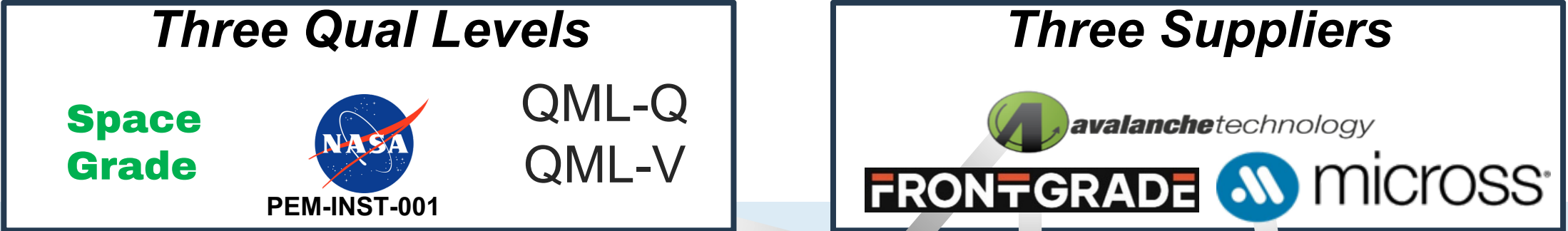Space Grade
PEMS through DPACI

Space Grade
QED, PEMS, and RadHard
30-year Hi-Rel Qual Heritage
Plastic, Die, Hermetic, and MCM

Space Grade
QED, PEMS, and RadHard
Standard and Custom
30-year Qual Heritage

Powered by Avalanche - Qual & Screening Ecosystem Options

Three Qual Levels

Space Grade — NASA PEM-INST-001 — QML-Q / QML-V

Three Suppliers

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Packaging		Plastic Encapsulated			Hermetic, Ceramic, MCM
Qual Level	JEDEC + 48 hour burn-in	NASA PEMS			QML
Vendor	avalanche technology	avalanche technology	FRONTGRADE	micross one source. one solution.	micross one source. one solution.
Product Family	Space Grade	QED Series*	UT8MRQ Series	QED Series*	Multiple
Avalanche MRAM Generation	Gen3	Gen3	Gen3	Gen2 & Gen3	Gen2 & Gen3
Comments	Representative radiation reports only.	The exact same packaged device, custom marked to vendor; each responsible for their own Qual & Screening flow. Datasheet of origin is Avalanche.			Multiple package, screening & radiation options for each
Space Grade-E DQSPI & Parallel — TID	100kRad	100kRad	100kRad	300kRad	300kRad
Space Grade-E DQSPI & Parallel — SEE	75MeV	75MeV	75MeV	75MeV	75MeV
Space Grade DQSPI — TID	75kRad	75kRad	75kRad	75kRad	75kRad
Space Grade DQSPI — SEE	45MeV	45MeV	37MeV	45MeV	45MeV
ITAR	No	No	Yes	Yes	Yes

* Subject to customer demand; initially Gen 3 High Density DQSPI

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Boot Solutions - Device Level

Enabled Booting and nvStorage for AMD/Xilinx Devices

SW-Defined Platforms for Space – Respond to Threats in Real Time
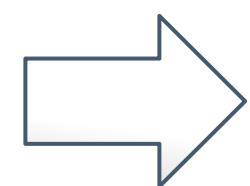
Support Resources Available

Family	Petalinux Support				Fabric Only
	23.2	23.1	22.2	22.1	No O/S
Versal	✓	✓	✓	✓	✓
Ultrascale+	✓	✓	✓	✓	✓
Ultrascale	✓	✓	✓	✓	✓

Historically supported by

PROM — Golden FPGA Images Boot Code

NOR — Alt Boot Images In-Orbit S/W updates

SRAM — Data Logging Execute Memory

+ Radiation Mitigation & Control Circuitry

Now

Gen3/22nm Dual QSPI
Space Grade 8Gb

PROM[1] Golden FPGA Images Boot Images *Read Only*

NOR[2] Alt Boot Images, RTOS, etc. In-Orbit S/W updates *Write Protectable*

P-SRAM[3] Data Logging Execute Memory *Read/Write*

No redundancy, mitigation or control needed
Dramatically simplified hw & sw architecture, rapid boot
In Orbit FOTA support: multi-mission adaptability ENABLED

https://www.avalanche-technology.com/support/development-kits/

Gen 3 Space Grade Dual QSPI P-SRAM™ Kit for Xilinx

Development Kit:
Download the User Guide
Download the Sample Code
Xilinx/AMD Versal Boot Linux Drivers

Reference Design:
Download the Schematic, Board Layout, Gerber, BOMs

Orderable Part Numbers:
Kit: AK30X208XILCCSOC
Socket: ABGA96-1-20×20

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Enabled auto-updating RT PolarFire's on-board Flash

Auto-updating RT PolarFire FPGAs w/MRAM

RT PolarFire use SFDP [Serial Flash Discoverable Parameters]. Part of the JESD216 standard.

Avalanche DQSPI MRAMs do not support SFDP.

However, Avalanche DQSPI MRAMs have successfully auto-updated the RT PolarFire's on-board flash using its extended address register.

App note will be available on June 1, 2024

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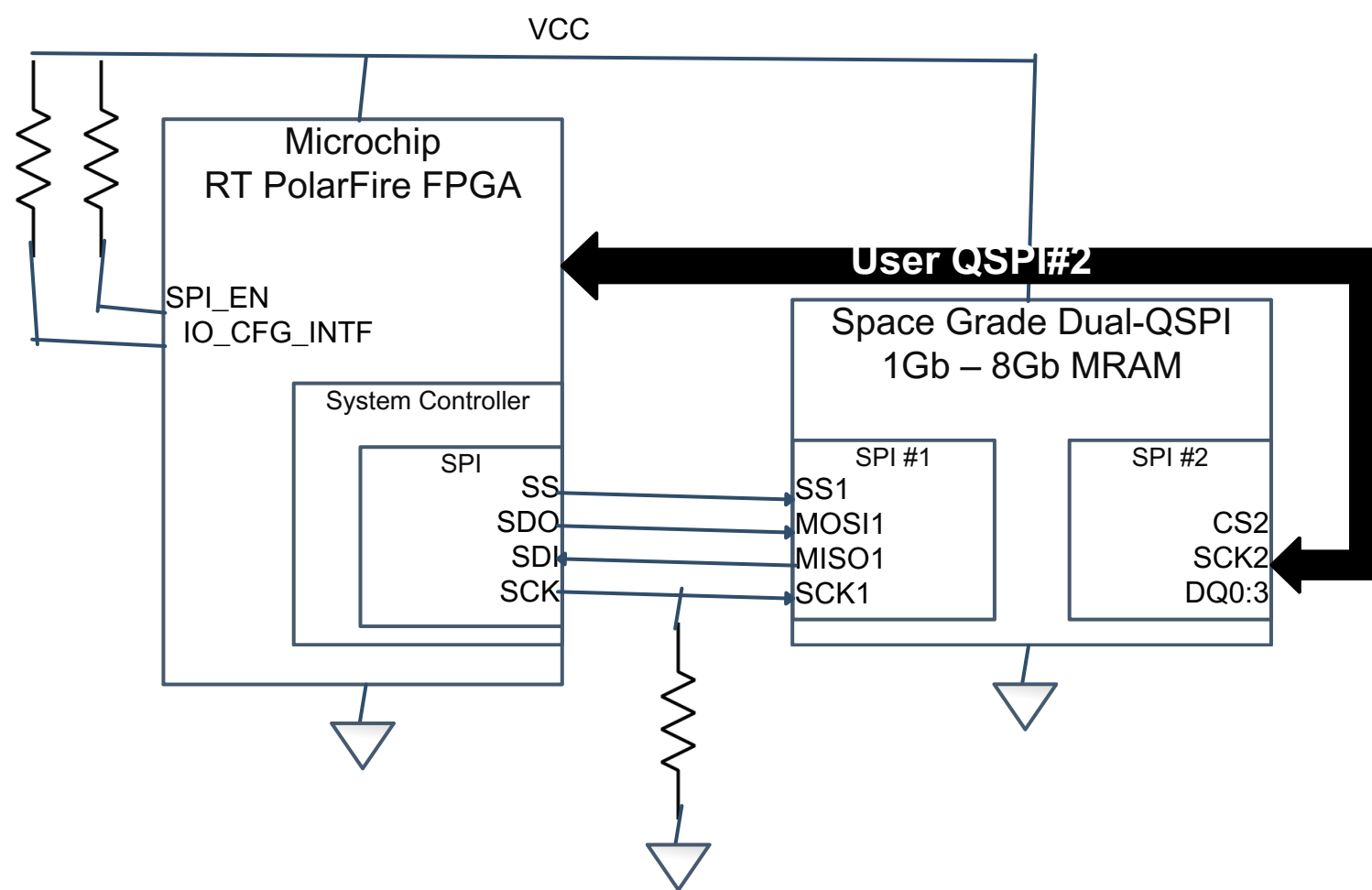
Mini-Boot: Low Density Serial (Dual QSPI) – 64Mb and 128Mb Gen3

10mm

Dual QSPI

64Mb and 128Mb

Gen3/22nm
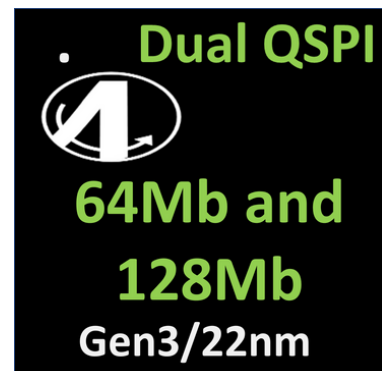
Gen 3 Devices
Sampling 2Q24

64Mb and 128Mb
1.3Mbits/mm² @ 10x10mm
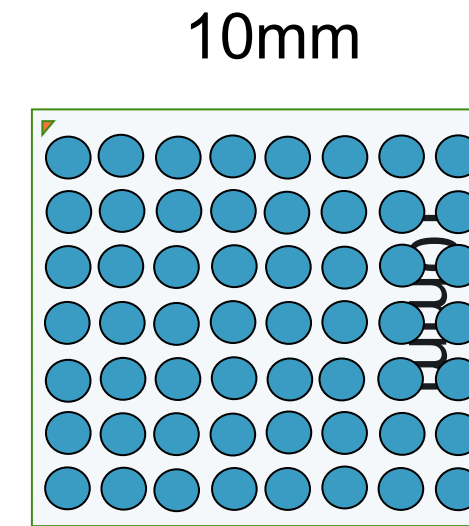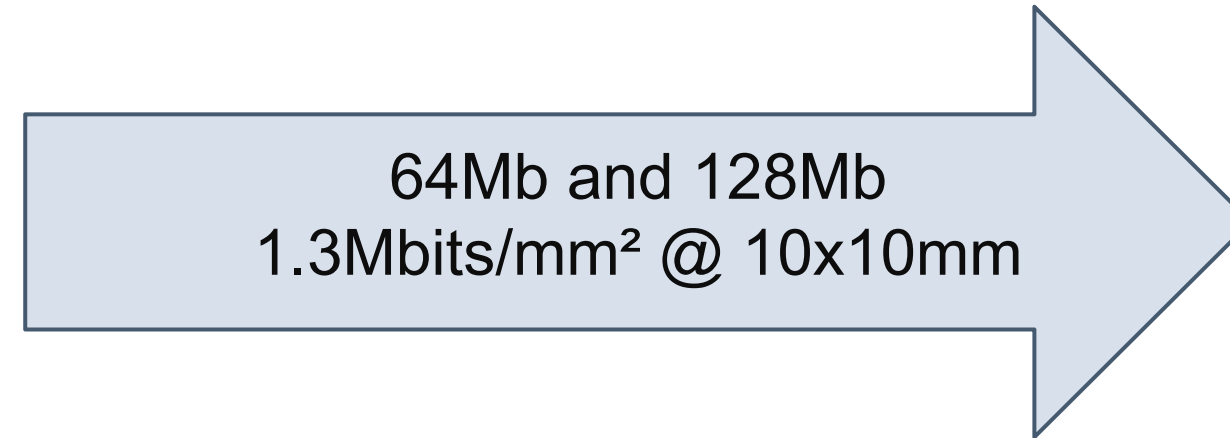
Gen 3 Die Form
Sampling 3Q24

		AV64M	
		X (um)	Y (um)
Die Size (W/O Scribe)		5118.03	3974.04
Scribe (80um)		80	80
Die Size (W/ 80u Scribe)		5198.03	4054.04
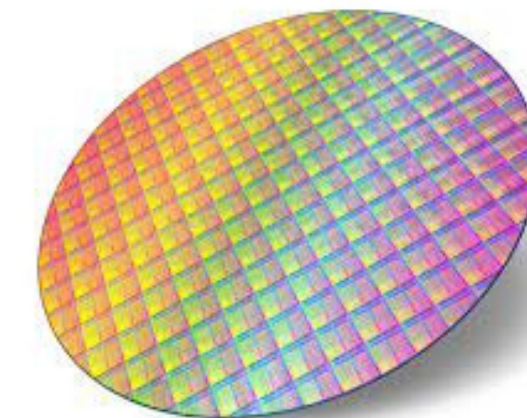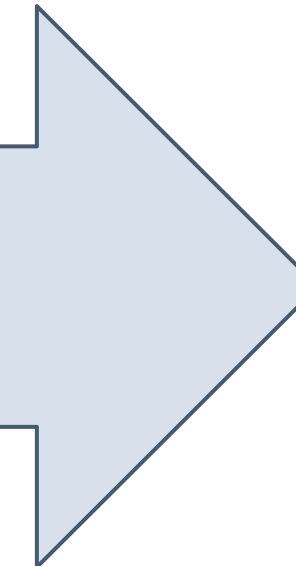
Die has Serial and Parallel Interfaces

Leverages Gen3 Radiation Legacy
Ultra Low Power (~15mA per device)
Ideal for Advanced SoC/FPGA boot
    Compact images
    Flexible, but robust write protection schemes
Single or Dual QSPI Interface

Coming soon to a popular RH SoC near you

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Enabling Booting for Frontgrade/Lattice CertusPro FPGAs

Config Bit Stream

Serial

Dual QSPI

64Mb and 128Mb

Gen3/22nm

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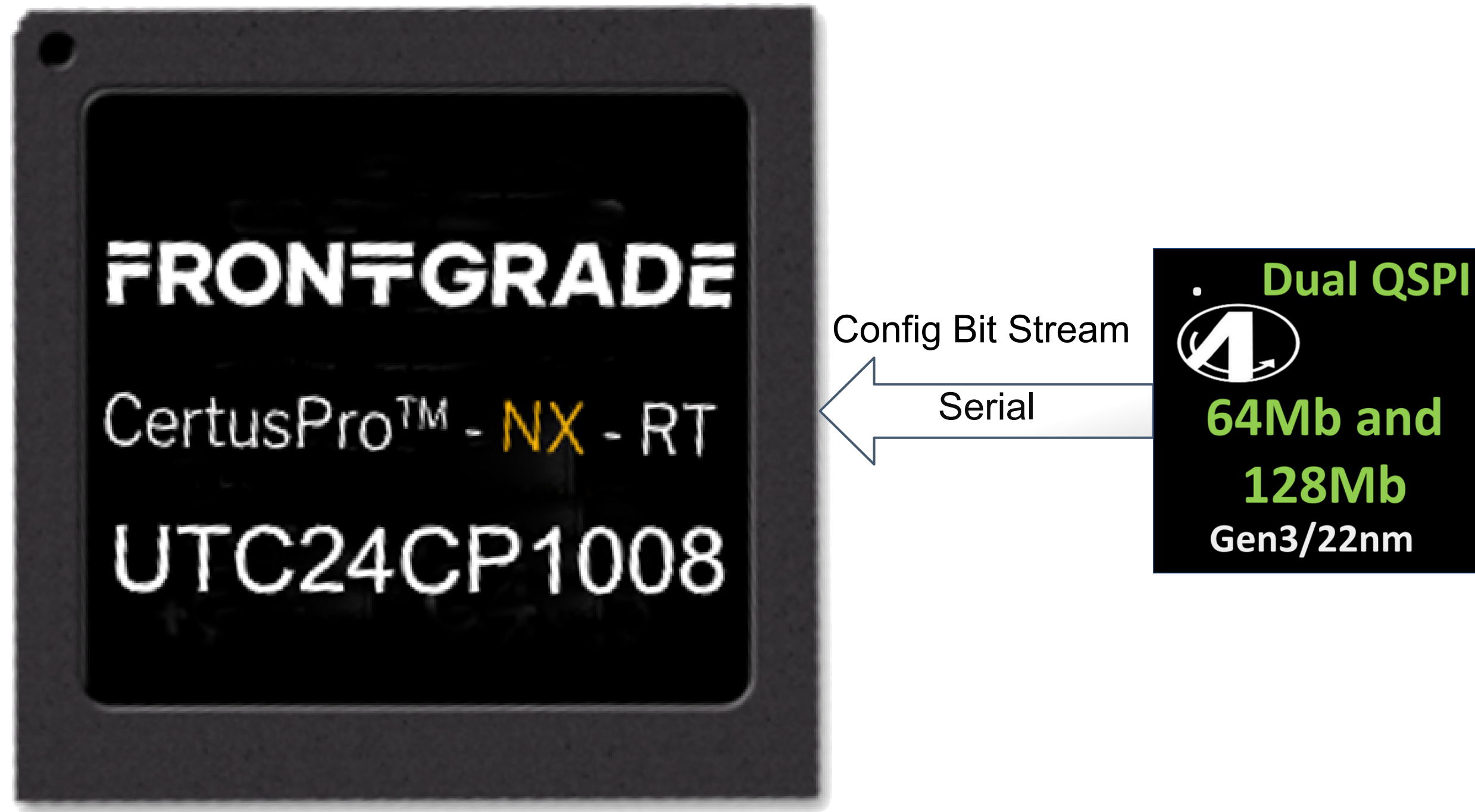
Enabling Booting for Vorago ARM-M4 Series Family SoCs

Config Bit Stream

Serial

Dual QSPI

64Mb and 128Mb

Gen3/22nm

VA41629-PQ176F0

2231BA411

Arm® Cortex®-M4

VORAGO

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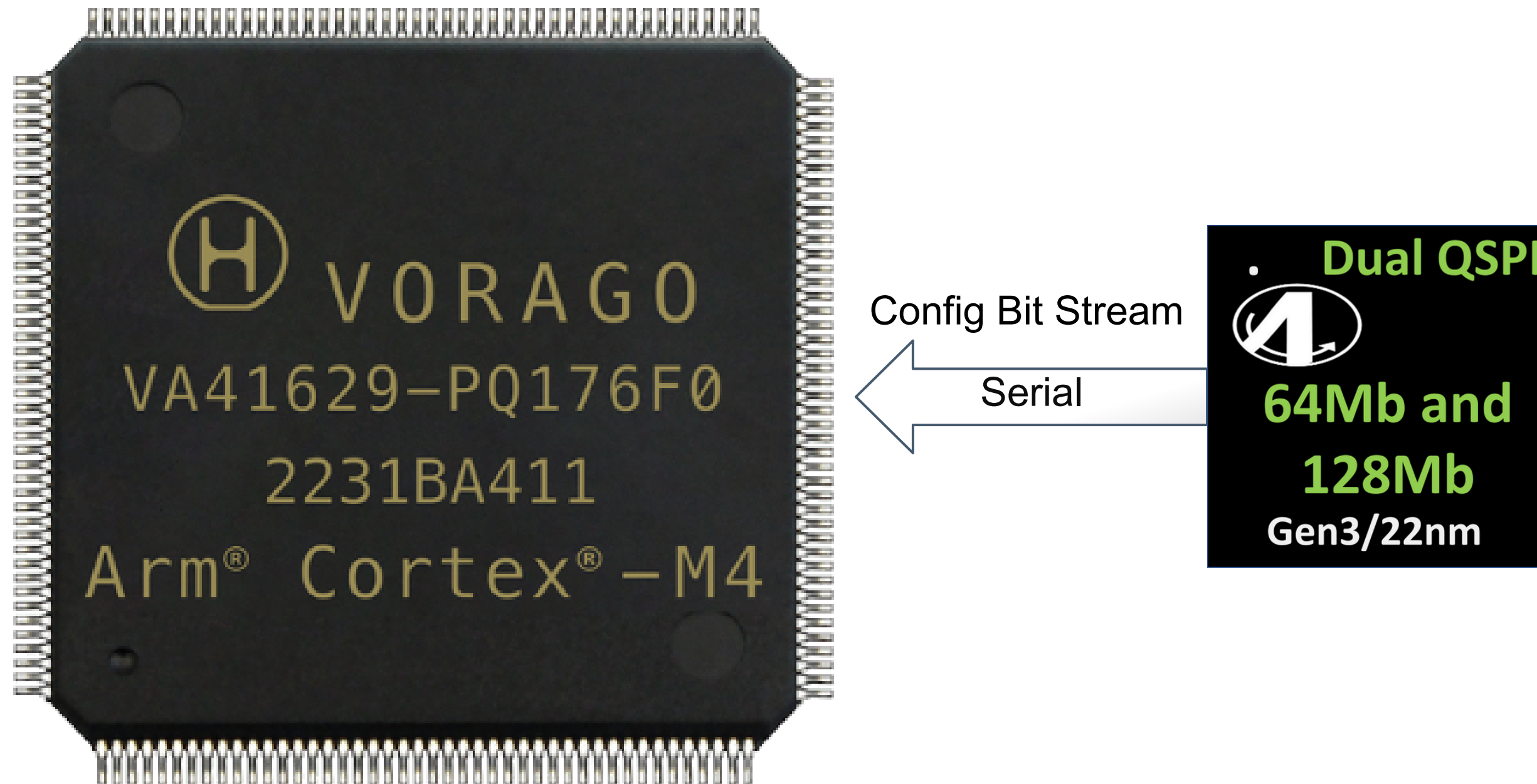
Enabling Booting & Working Memory for Gaisler GR716 LEON3FT Processor

Config Bit Stream

Serial

Dual QSPI

64Mb and 128Mb

Gen3/22nm

OR

Config Data

Parallel x16

& Working Mem

64Mb Die

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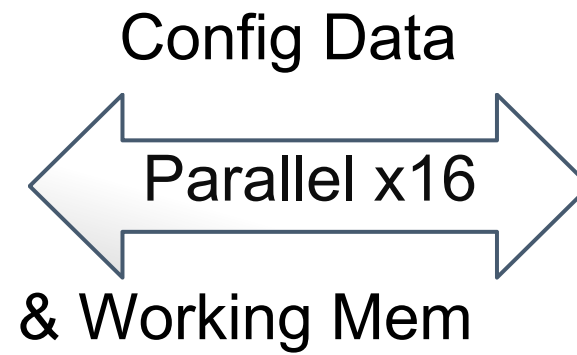
Enabled Platforms - Storage

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Avionics and Space Grade Storage Class Products
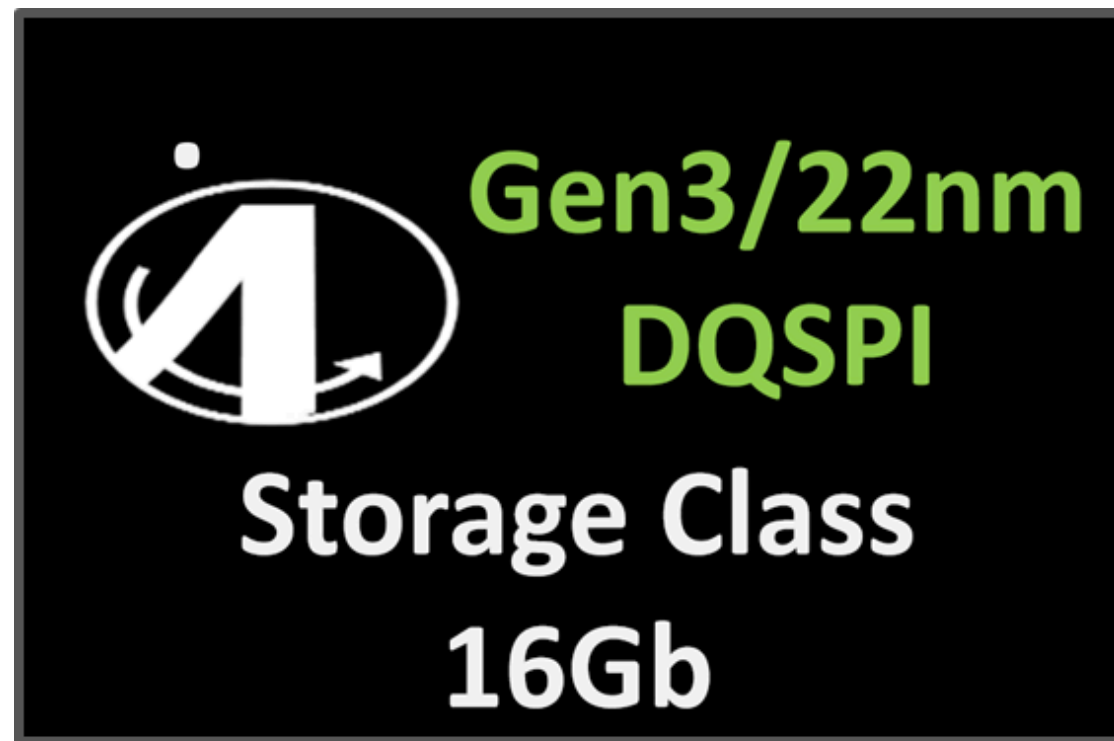
16Gb MRAM Single Chip
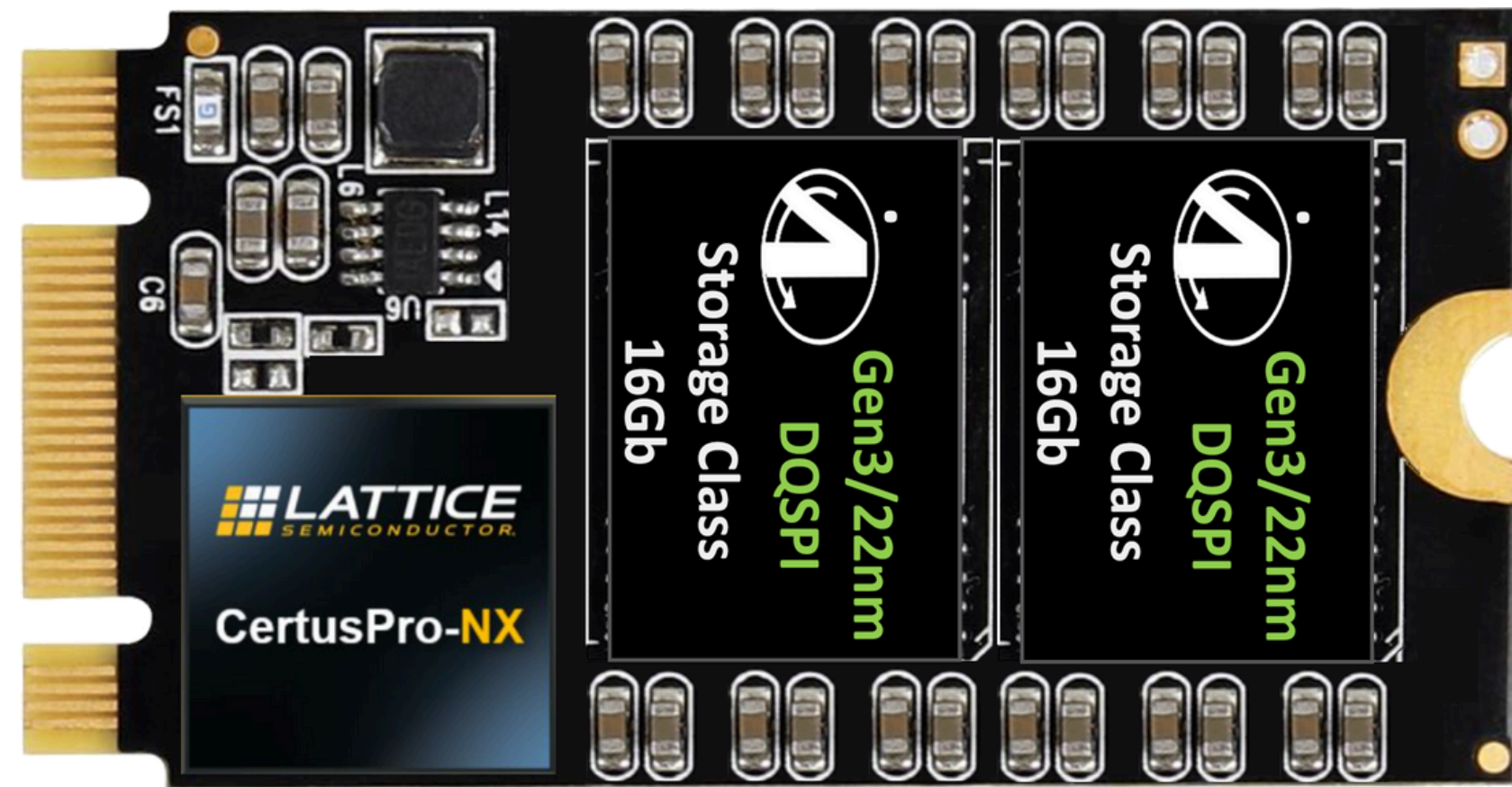
M.2 64Gb (8Gbyte) MRAM Module
EM configuration uses standard M.2 connector
Ruggedized modules use BGA mounting style

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Enabling the driver for Storage Solutions in Space
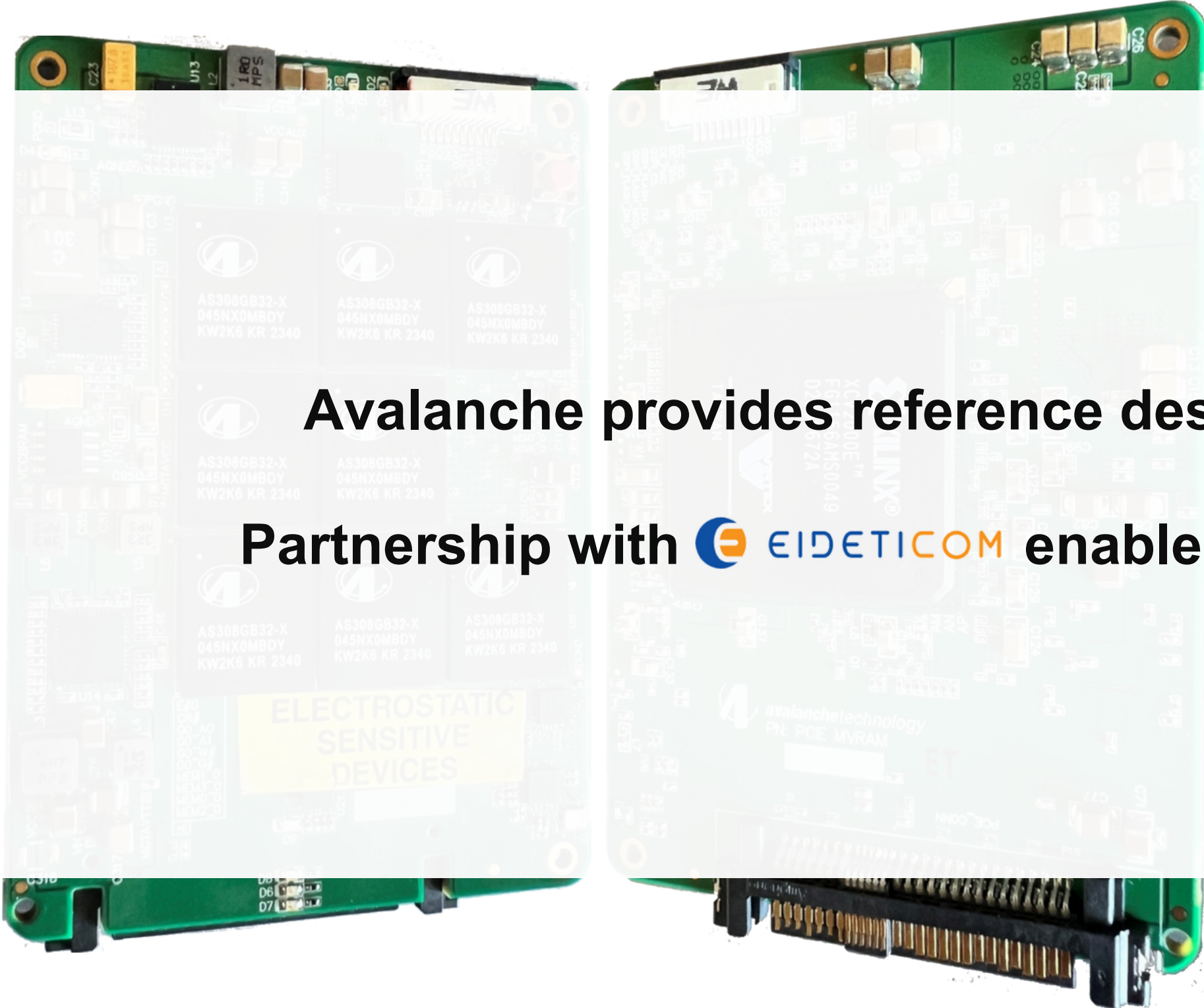
Avalanche provides reference design with low level drivers

Partnership with EIDETICOM enabled plug and play NVMe stack

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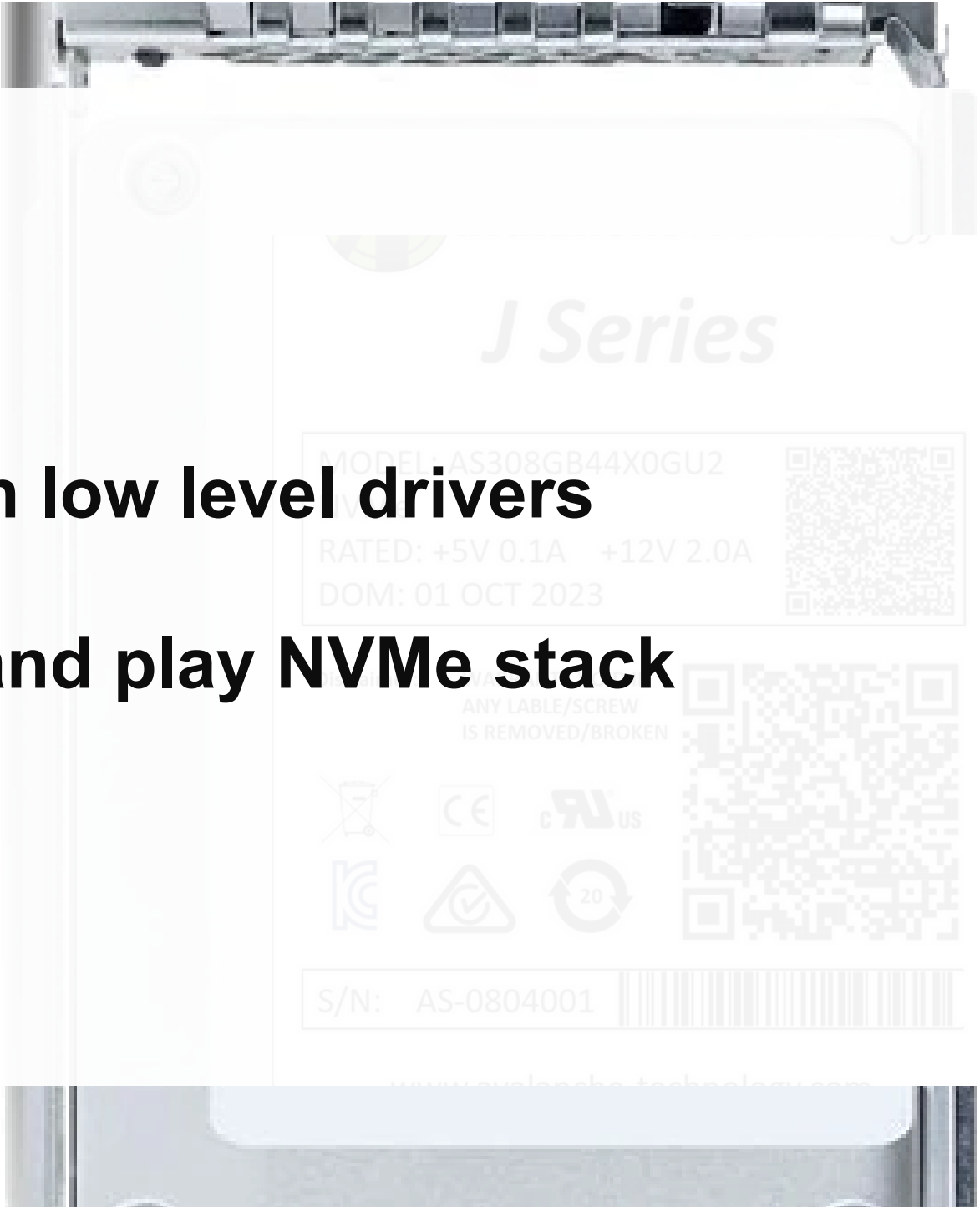
BLUEHALO® enabled 8Gbyte MRAM Data Buffer

8GByte All MRAM Data Buffer

Licensed NMVe stack from EIDETICOM

AI Memory: Xilinx KU060 FPGA supports data operations:
    Compression, Cyber Security, Parameter Extraction, etc.

High performance SSD

10^{16} Write Cycle Endurance

Low power

3U VPX

Affordable

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enabled 8Gbyte Customizable Mezzanine Card

3U SpaceVPX Processor Board
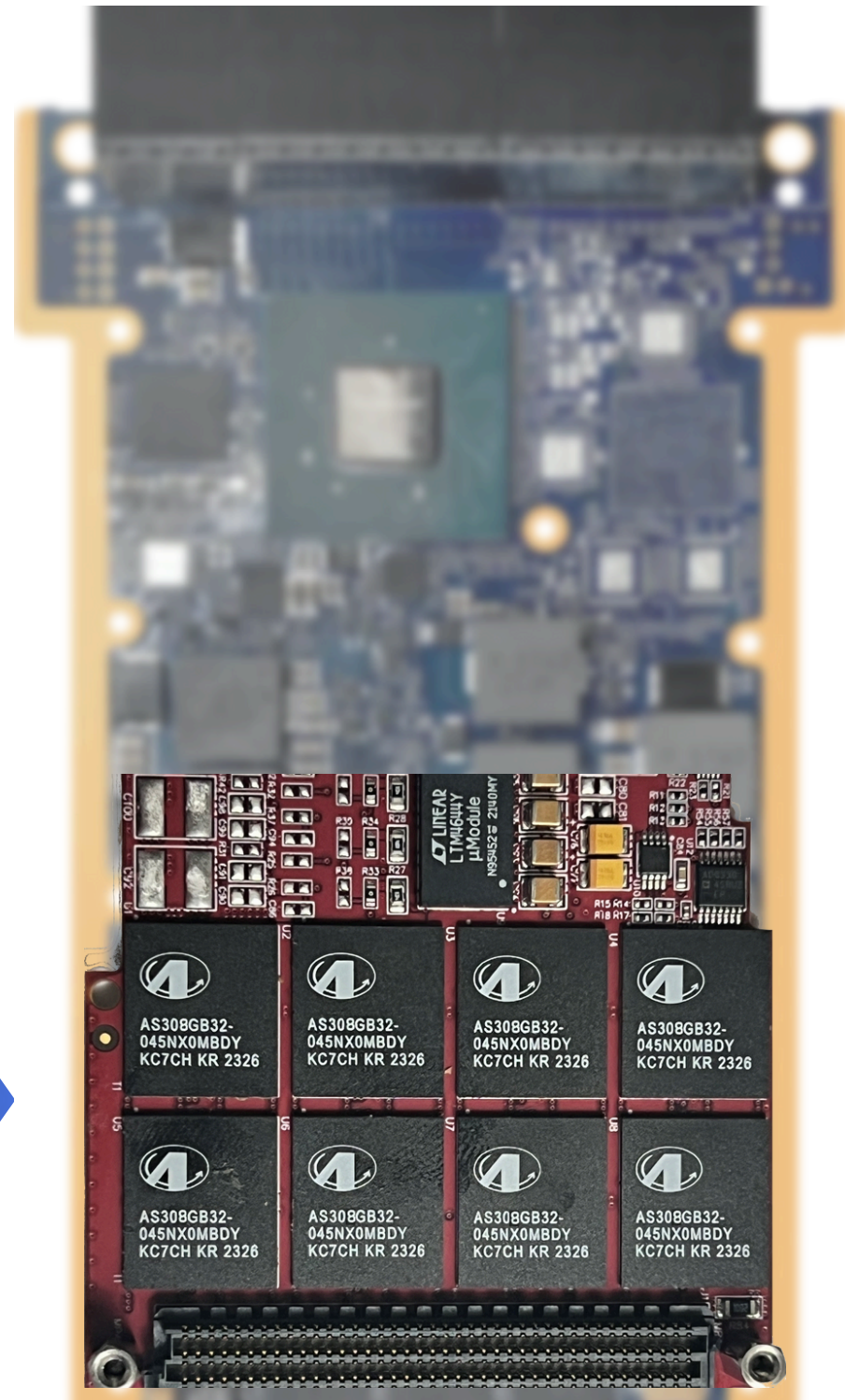
MRAM Data Buffer on mezzanine card

MRAM 8GByte Cache daughter card
- Utilizes existing Xilinx Zynq board

Hi-Rel 3U VPX board based on Agilex-5
- Plan to make FMC compatible with MRAM Cache card

Radiation Circumvented 3U VPX board
- TSS developing PDDIC that detects, circumvents, and recovers from a radiation event
- Will use the Agilex-5

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mercury enabled Hybrid (MRAM+NAND) SpaceDrives

Enabled Platforms - Board & Device

Advanced Boot Solutions Enabling SW-Defined Platforms

Avalanche Technology Announces Support for NASA PEMS Qualification and Screening

Avalanche Technology Selected to Support Mercury's First Space-Qu Processing Board Using AMD's Xilinx Versal AI Core

PRESS RELEASE

Announcing Supp
NASA PEMS Quali
and Screenir
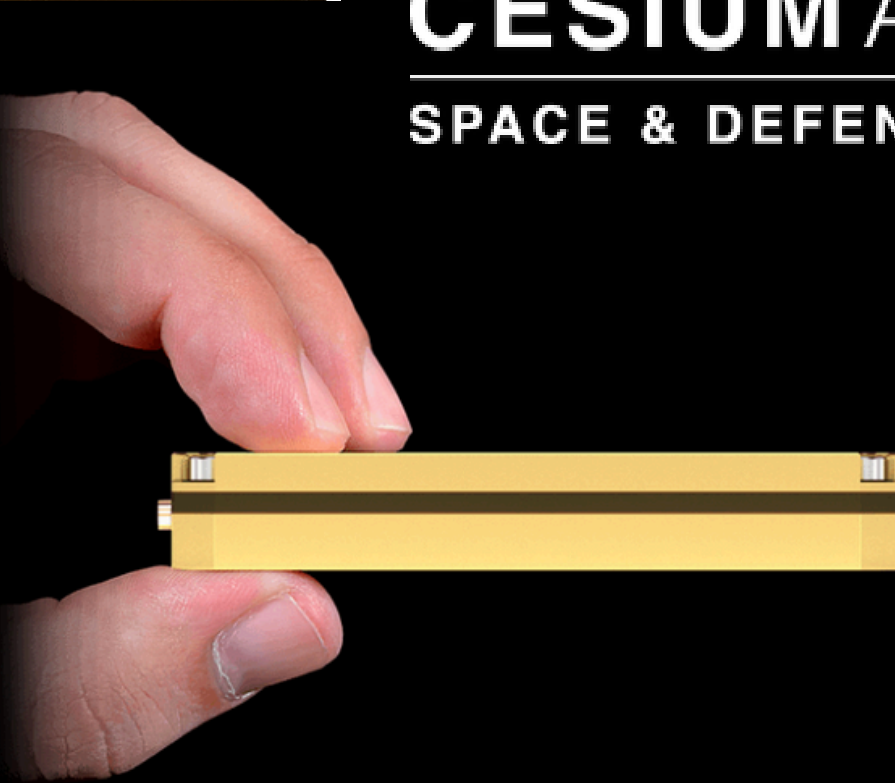
In response to unprecedented demand for extended qualification & scr
compatible NASA PEMS options for enabling Dual QSPI MRAM family.

FREMONT, CA, April 8, 2024 — Avalanche Technology, the leader in
announced today the launch of a new product derivative to address
aerospace and defense community for extended qualification and screening solutions, particularly NASA
PEMS INST-0001.

Leveraging Avalanche's Gen 3 Space Grade MRAM products being broadly adopted by the defense
industrial base and commercial space customers, the new pin compatible PEMS qualified and screened
versions of the popular Dual QSPI MRAMs will roll out mid-year.

...o build the next family of SWaP optimize

...alanche Technology, the leader in next
...ersistent-SRAM (P-SRAM) products were
by Mercury Systems for the new SCFE6933, a next-generation processor board that will enable fa
processing of data in orbit. The high-density 8Gb DQSPI Space Grade Persistent SRAM with furthe
scalability is the ideal companion to the AMD (Xilinx) Versal Adaptive SoC platform that is feature
platform.

Support Resources @ www.avalanche-technology.com

Datasheets, models, reference designs
Boot module: Petalinux drivers, User Guide (Versal boot)
Gen 3 reference designs
IBIS & Verilog models

Radiation test reports
Gen 2 test report accessed via website (NASA)
Gen 3 reports available by request

Visionary White Papers
Innovation enabled by Avalanche
Data Centers in Space…
…why the key to satellite scalability and resilience
NEW: AI Computing in Space
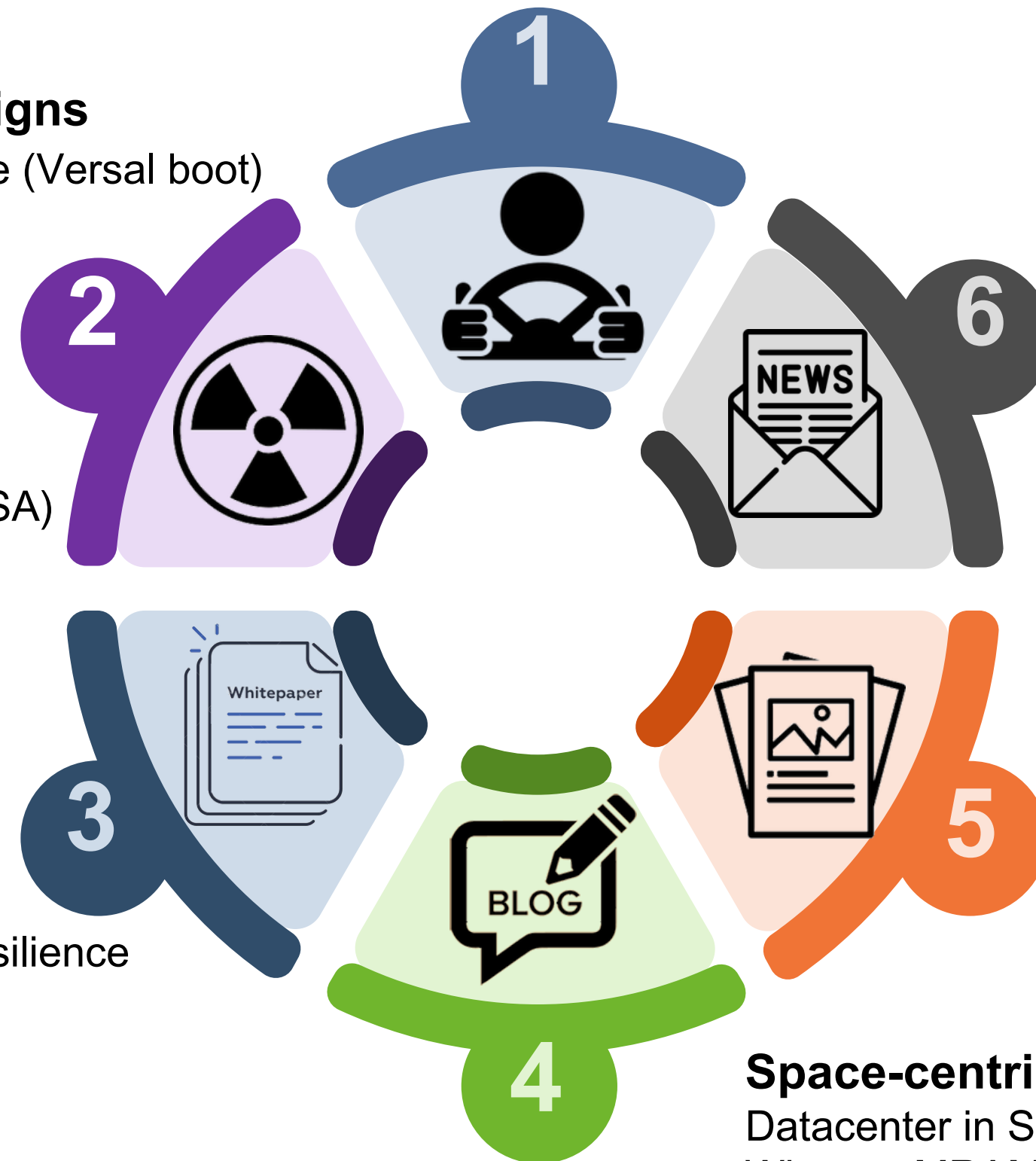
Newsletters
Quarterly, *register on main page*

Brochures
Overall MRAM tech for hi-rel apps
Space Grade products

Space-centric Blogs
Datacenter in Space series
Why our MRAM is ideal for space

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Recap

Avalanche MRAM/Processing Product Roadmap

Parallel

Gen2/40nm Parallel — Space Grade 16Mb and 64Mb

Gen3/22nm Parallel — Space Grade 1Gb, 2Gb, 4Gb, and 8Gb

High-performance Non-volatile working memory for advanced systems

Serial (Boot)

Gen2/40nm SPI — Space Grade 16Mb

Gen3/22nm Dual QSPI — Space Grade 1Gb, 2Gb, 4Gb, and 8Gb

Dual QSPI 64Mb and 128Mb Gen3/22nm

Gen3/22nm Dual QSPI HP Space Grade 4Gb and 8Gb

NASA TBD

Gen4/1Xnm DQSPI/OSPI Space Grade 64Gb and 128Gb

Small Boot/MCM + Scaling Density for Multi-Mission Boot & Unified Memory

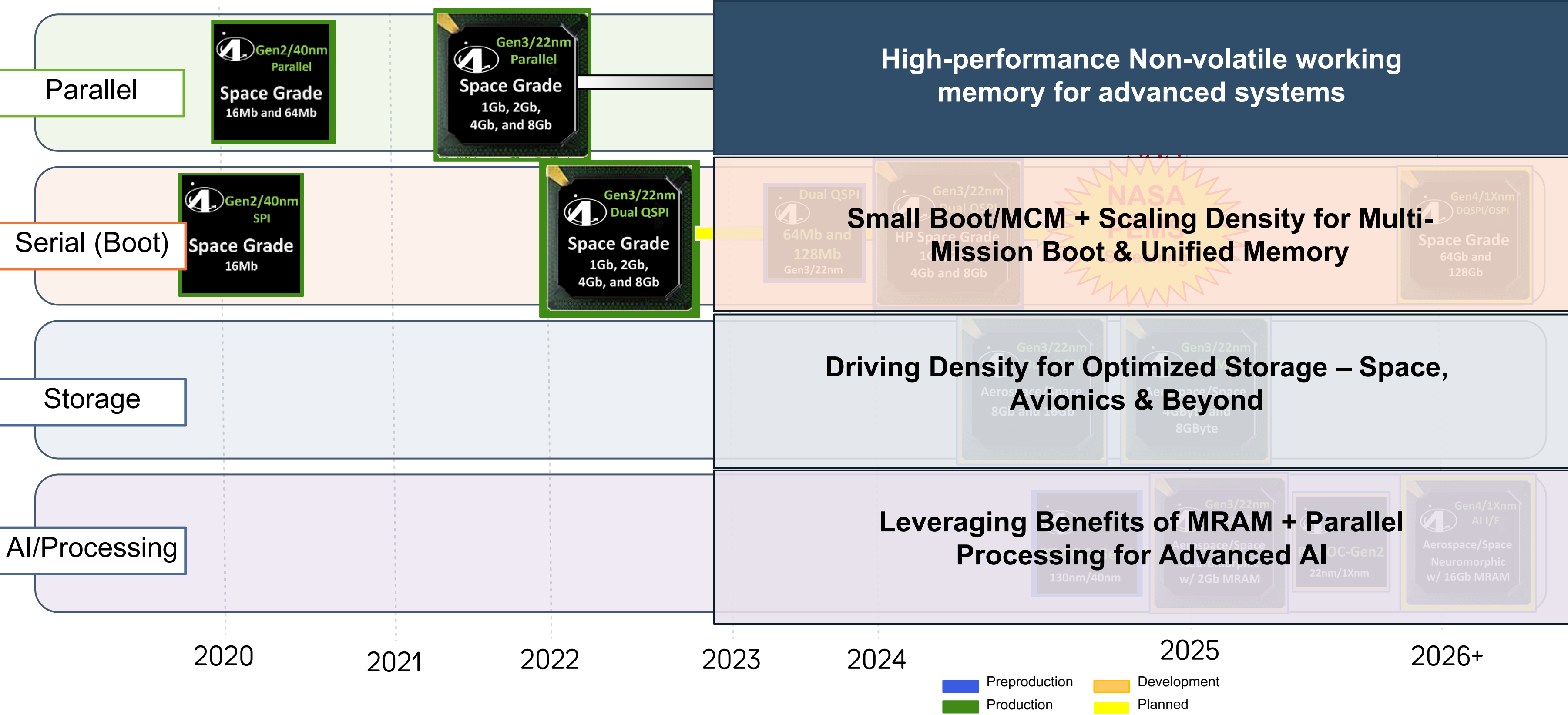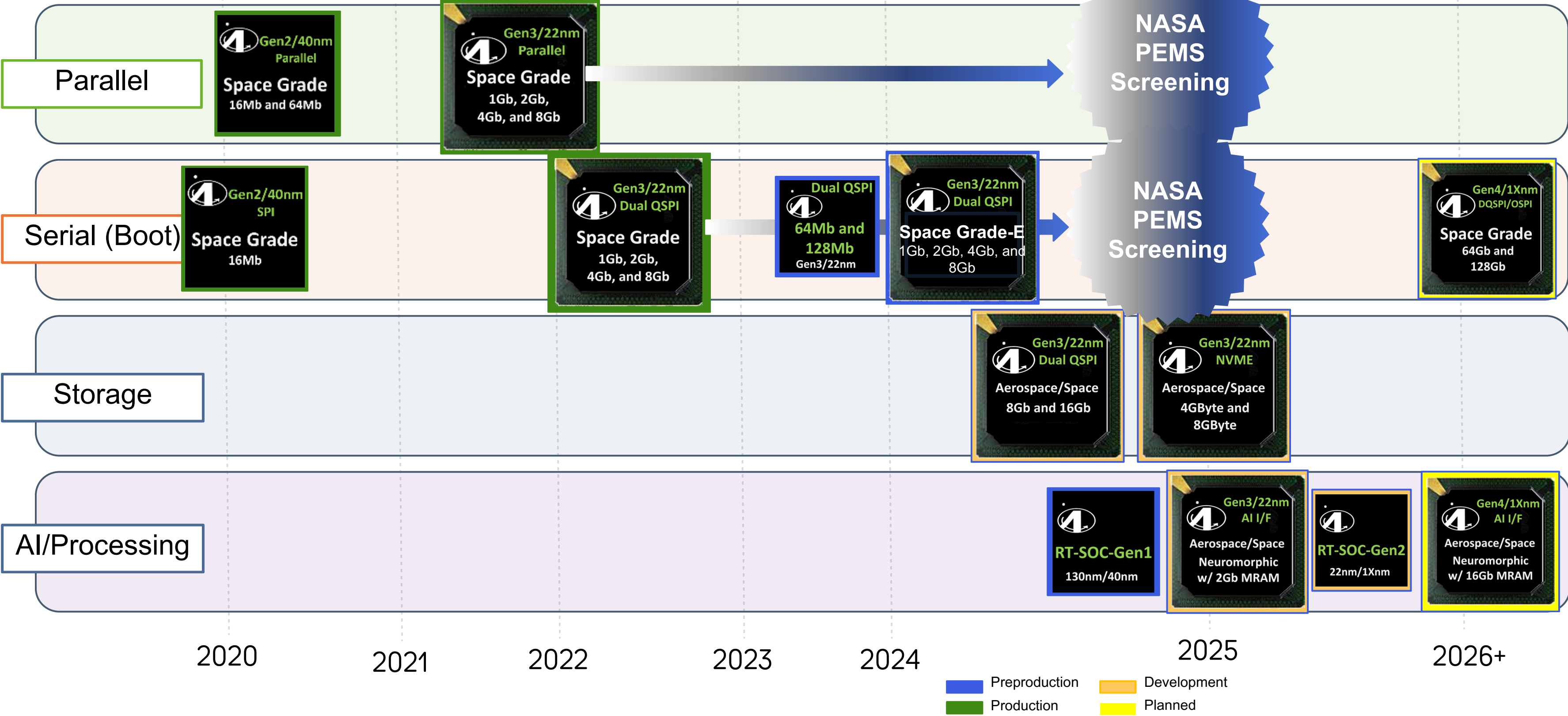**Storage**

Gen3/22nm Aerospace/Industrial 8Gb and 16Gb

Gen3/22nm Aerospace/Space 16Byte/ano 8GByte

Driving Density for Optimized Storage – Space, Avionics & Beyond

AI/Processing

Gen3/22nm Aerospace/Space 130nm/40nm

Gen3/22nm SOC-Gen2 w/ 2Gb MRAM 22nm/1Xnm

Gen4/1Xnm AI I/F Aerospace/Space Neuromorphic w/ 16Gb MRAM

Leveraging Benefits of MRAM + Parallel Processing for Advanced AI

2020   2021   2022   2023   2024   2025   2026+

- Preproduction
- Production
- Development
- Planned

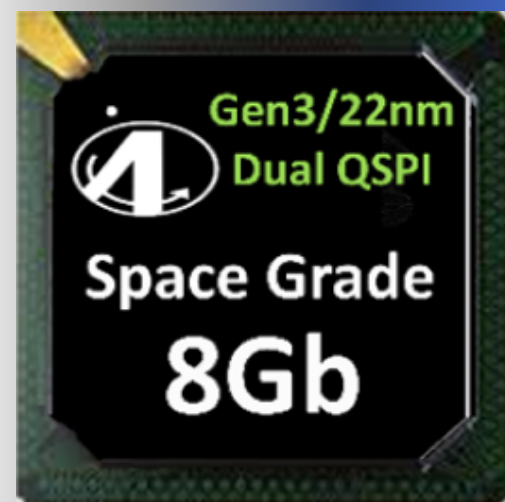*avalanche technology*

Avalanche MRAM/Processing Product Roadmap

Thank You

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